

**CLAIMS**

- 1) A process to recover carotene concentrates comprising the steps of:
  - 5           i)     subjecting alkyl esters produced from palm oil to at least one stage vacuum distillation at temperature ranging from 80-220°C and pressure at less than 40mTorr to yield phytonutrients concentrate in residue;
  - ii)    separation of polar lipids and other impurities from the residue in step (i);
  - 10          iii)   subjecting the treated residue from step (ii) to a second vacuum distillation wherein residue from the distillation contain carotenes concentrates consisting carotenes, ubiquinones and phospholipids;
- 15       2) A process to recover carotene concentrates claimed in claim 1 wherein the second vacuum distillation is carried out at temperature ranging from 80°C to 200°C and at pressure less than 40mTorr.
- 20       3) A process to recover carotene concentrates as claimed in claim 1 wherein the separation of polar lipids and other impurities in step (ii) is done in any one of the ways consisting of:
  - i)     treating the residue in step (i) of claim 1 with a hydrocarbon solvent with or without subsequent alkyl alcohol/ treated water purification to remove the monoacylglycerols; or
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  - iii)    direct filtrating of residue in step (i) of claim 1 under vacuum.

- 4) A process to recover carotene concentrates as claimed in claim 3 wherein the mixture in step (i) is chilled down to low temperature for at least 2 hours and monoacylglycerols is separated from the residue.
- 5) A process to recover carotene concentrates as claimed in claim 3 wherein alkaline catalyst used in the re-transesterification in step (ii) is selected from a group consisting of such as sodium hydroxide, potassium hydroxide and sodium methylate in the presence of short and branched alkyl alcohol such as methanol and ethanol.
- 6) A process to recover carotene concentrates as claimed in claim 3 wherein 2% of palm oil ethyl esters are added to the treated residue in step (iii) prior to subsequent vacuum distillation.
- 7) A process to recover carotene concentrates as claimed in claim 1 wherein the carotenes concentrate is further purified by either:
- i) adding alkaline catalyst in presence of alkyl alcohol such as potassium hydroxide in ethanol; or
  - ii) adding hydrocarbon solvent and alkyl alcohol and chilled to  $-10^{\circ}\text{C}$  for at least one hour to partition the carotenes into hydrocarbon layer.
- 8) A process to recover carotene concentrates as claimed in claim 3 and 7 wherein the hydrocarbon solvents used are hexane or iso-octane and the alkyl alcohols used are short and branched alkyl alcohols such as methanol and ethanol.
- 9) A process to recover carotene concentrates as claimed in claim 1 wherein the alkyl esters is produced from the crude palm oil or treated palm oil such as bleached and degummed palm oil and membrane filtered palm oil.

10) A process to recover carotene concentrates as claimed in claim 9 wherein the removal of excess of alkaline catalyst in alkyl esters produced is carried out by using acidified water pH between 4-5.

5 11) Carotenes, ubiquinones, and phospholipids as produced in any of the claims 1 to 10.

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